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Role of Trust and Compassion in Willingness to Share Mobility and Sheltering Resources in Evacuations: A Case Study of the 2017 and 2018 California Wildfires

WORKING PAPER

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ABSTRACT

Advances in the sharing economy – such as transportation network companies (e.g., Lyft, Uber) and home sharing (e.g., Airbnb) – have coincided with the increasing need for evacuation resources. While peer-to-peer sharing under normal circumstances often suffers from trust barriers, disaster literature indicates that trust and compassion often increase following disasters, improving recovery through additional resources and support. We hypothesize that trust and compassion could trigger willingness to share transportation and sheltering resources during an evacuation.

To test this hypothesis, we distributed a survey to individuals impacted by the 2017 Southern California Wildfires (n=226) and the 2018 Carr Wildfire (n=284). We estimate binary logit choice models and find that high trust in neighbors and strangers and high levels of compassion significantly increase willingness to share across all scenarios. Assuming a high trust/compassion population versus a low trust/compassion population results in a change of likelihood to share between 30% to 55%, depending on scenario. Variables related to departure timing and routing – which capture evacuation urgency – increase willingness to share transportation. Volunteers in past disasters and members of community organizations are usually more likely to share, while families and previous evacuees are typically less likely. Significance of other demographic variables is highly dependent on the scenario. Though spare seatbelts and bed capacity increase willingness, they are largely insignificant. These results suggest that future sharing economy strategies should cultivate trust and compassion before disasters via preparedness within neighborhoods, community-based organization, and volunteer networks, during disasters through communication from authority figures and public officials, and after disasters using resilience-oriented and community-building information campaigns.

Keywords: Evacuations, sharing economy, shared mobility, trust, compassion, transportation network companies (TNCs), ridesourcing, ridehailing, homesharing, California wildfire

1. INTRODUCTION

Beginning with Hurricane Sandy in 2012, the sharing economy has been active in 30 disasters in the United States (U.S.) through home sharing (e.g., Airbnb) and transportation network companies (TNCs, also known as ridesourcing and ridehailing) (e.g., Lyft, Uber) (Wong et al., 2019). While early sharing economy company actions were largely ad hoc, recent actions stem from highly structured disaster relief policies. For example, during the Woolsey Fire (2018) in Southern California, Lyft and Uber both offered ride credits to and from evacuation centers, while Airbnb activated its Open Homes Program, allowing hosts to offer free housing to evacuees. Even with these private company resources, public agencies may still lack resources to evacuate and shelter all citizens, particularly for mass hurricane evacuations and mass wildfire evacuations (e.g., Carr Fire, Camp Fire, and Woolsey Fire in California in 2018). A significant number of people also continue to have poor access to transportation, sheltering, or both. Consequently, shared resources from private citizens could encourage more individuals to evacuate and improve equitable outcomes.

Despite considerable literature in evacuation logistics and behavior (Lindell et al., 2019), the feasibility of the sharing economy in evacuations as a potential logistical strategy remains largely unstudied (Wong et al., 2018; Wong and Shaheen, 2019), along with influencers of this sharing behavior. Under normal circumstances, individuals have significant reservations about sharing resources, especially with respect to trust. This becomes more problematic with persistent myths of looting and social discontent during disasters (Tierney et al., 2006). Concurrently, compassion through resource support, charitable donations, and recovery assistance is widespread across disasters. In 2017 and 2018, roughly 30% of U.S. households donated money to disaster aid, while 12% volunteered in a disaster (Indiana University Lilly Family School of Philanthropy, 2019).

Thus, we hypothesize that two social variables – trust and compassion – influence willingness to share in an evacuation. To test this hypothesis, we distributed two surveys to individuals impacted by the: 1) 2017 December Southern California Wildfires (n=226) and 2) 2018 Carr Wildfire (n=284). We first present background on evacuation logistics, the sharing economy, trust, and compassion in disasters. Next, we describe our methodological approach of employing binary logit choice models across four hypothetical sharing scenarios to identify influencers of willingness to share. We then present logistic, trust, compassion, and sharing concern results from our survey and discuss the models for both wildfires. Finally, we conclude with several recommendations for building a sharing economy evacuation strategy.

2. LITERATURE

In this section, we discuss several related areas from the literature including: 1) evacuation logistics, 2) the sharing economy in disasters, 3) trust in disasters, 4) compassion in disasters, and 5) literature gaps.

2.1 Evacuation Logistics

Evacuations require multiple logistic resources – specifically transportation and shelter – to ensure that individuals are safe. Lindell et al. (2019) reviewed this literature, describing that evacuation logistics involved evacuee's transportation mode, number of vehicles, route, destination, and shelter. Most work on evacuation logistics has largely assessed the modal split or

shelter type split, which indicate the demand level. Resource demand, in turn, impacts evacuation metrics (e.g., evacuation time estimates), which can be managed through mechanisms that typically increase supply (i.e., reversing lanes via contraflow).

For transportation, hurricane evacuation studies have found that many evacuees use a personal vehicle, ranging from 87% to 96% of evacuees (Prater et al., 2000; Lindell et al., 2011; Wu et al., 2012; Wilmot and Guidshala, 2013; Wu et al., 2013; Wong et al., 2018b). These same studies found that between 2% and 10% received a ride from someone else, while 1% or less used public transit. Evacuees also often took extra vehicles, ranging from 1.10 vehicles to 2.15 vehicles per household (Prater et al., 2000; Lindell et al., 2011; Wu et al., 2012; Wu et al., 2013). Households sometimes take additional vehicles to transport all household members, pack additional luggage, or protect from the disaster.

Sheltering is another key evacuation logistic that indicates housing demand, including public shelters. Across hurricane studies, the majority of evacuees stayed with friends or family, ranging from 44% to 70% (Prater et al., 2000; Whitehead, 2003; Smith and McCarty, 2009; Cheng and Wilmot, 2011; Lindell et al., 2011; Wu et al., 2012; Wilmot and Gudishala, 2013; Wu et al., 2013; Yin et al., 2014; Wong et al., 2018b). These studies found relatively low public shelter use (2% to 11%), while a significant number of evacuees used hotels/motels, ranging from 7% to 46%. Wong et al. (2018b) also found that 5% of evacuees used a peer-to-peer platform, such as Airbnb, to find sheltering for Hurricane Irma.

2.2 The Sharing Economy in Disasters

The sharing economy is a collection of Internet-based transactions where goods are shared or obtained (Hamari et al., 2016). For this study, we focus on several mobility sectors along with home sharing to potentially aid in disaster relief:

- Transportation Network Companies (TNCs): On-demand access where users request rides through a smartphone application.
- Carpooling: Grouping of travelers for trips that would have otherwise occurred.
- Carsharing: Short-term access to vehicles, while forgoing auto ownership costs.
- Bikesharing: On-demand access to bicycles for one-way or roundtrip travel.
- Scooter sharing: On-demand access to electric scooters for one-way or roundtrip travel.
- Home sharing: A marketplace for homes and rooms where people host and rent their space.

In disasters, three private companies – Airbnb, Lyft, and Uber – have been primary actors in disasters. Wong et al. (2019) reviewed the sharing economy in evacuations by assessing past private company actions, interviewing experts in the emergency space, and surveying evacuees from Hurricane Irma. The research found some benefits of the sharing economy for public agencies (e.g., resource redundancy, supporting vulnerable populations, and information sharing opportunities) and private companies (e.g., positive press coverage, improved business continuity, and stronger community connections). Still, limitations included fostering driver and host reliability, ensuring safety, reducing surge pricing, determining liability, reducing congestion on roadways and wireless networks, and overcoming the digital divide (i.e., inequality in accessing computers/Internet).

Despite these limitations, private companies remain active in disasters. Airbnb deploys its Open Homes Program following most major disasters, allowing users to provide their home for

free to evacuees (Airbnb, 2018). Lyft employs its Wheels for all Program, partners with organizations including the American Red Cross, United Way, and Team Rubicon, and offers ride credits to and from evacuation centers (Lyft, 2018). Uber operates its Global Security Center and offers ride credits to and from evacuation centers (Hawkins, 2018). Given the increased structure of disaster relief, private companies are likely to continue and improve their assistance.

Along with the business-to-peer mechanisms, the sharing economy also comprises private citizens who exchange goods and services via the Internet (peer-to-peer). For Hurricane Irma, Wong et al. (2019) found that private citizens were moderately likely to share resources to evacuees for a future evacuation, but more so for transportation. Wong and Shaheen (2019) found similar results, while also conducting four focus groups of vulnerable populations (low-income, older adult, individuals with disabilities, and Spanish-speaking). All groups expressed low trust of both drivers and companies in disasters. Groups offered recommendations for developing a sharing economy framework, including planning in advance, widely disseminating resource opportunities, and building a community-based approach (e.g., neighbors helping neighbors). Other recent work has assessed shared mobility potential in China by surveying potential evacuees, experts, and TNC drivers (Li et al., 2018). While this study sampled respondents without disaster experience, it found shared mobility could be a viable evacuation option, including no-notice situations in city centers (Li et al., 2018). For carless individuals, 83% would have taken shared mobility in a hypothetical disaster. This research also found that shared mobility could reduce the number of intermediate trips (i.e., trips to pick up family members), thus decreasing total simulated evacuation trip time. Most recently, research conducted by Borowski and Stathopoulos (2020) assessed TNC potential for no-notice evacuations through a mode choice model that incorporated demographic variables, context, warning message content, and emotionality. Borowski and Stathopoulos (2020) found that perceived urgency from the given scenarios increased TNC use. Moreover, they found that young adults, those in unfamiliar locations, and people who needed to travel far distances were less likely to use established modes (i.e., personal vehicles, carpool, public transit). This study, along with Wong et al. (2020), mark a key shift in recognition of shared mobility (and shared housing) as possible transportation modes.

Other related work to the sharing economy strategy has focused on the role of social networks in evacuation decision making, finding that the strength of social networks is a key influencer of evacuation choices (Madireddy et al., 2015; Sadri et al., 2017a; Sadri et al., 2017b; Sadri et al., 2018). For example, Sadri et al. (2017a) found that social partners that contact each other daily and live near each other were more likely to both evacuate. The geographical proximity indicated that some special evacuation resources could be distributed and would help impact social partners' decision making in a similar manner.

2.3 Trust in Disasters

The full capacity of transportation and sheltering resources remains untapped in disasters, perhaps due to lack of trust. Individuals tend to distrust strangers and only 35% of Americans agreed that "most people can be trusted" (World Values Survey, 2014). Lack of trust can also be a major barrier to consuming collaboratively under even normal conditions (Möhlmann, 2015; Hamari et al., 2016). In disasters, research has found mixed results. After disasters, impacted communities typically displayed higher levels of trust across countries and disaster types (Toya and Skidmore, 2014). However, trust of institutions (e.g., the government) was often lower (Hommerich, 2012) and social trust substituted for these institutions and even markets (Yamamura

et al., 2014). Other work found that trust levels did not change following disasters, and reciprocity (i.e., giving back to others who helped) was lower in impacted areas (Fleming et al., 2014). More positively, if social trust was high in a community before a disaster, then trust-increasing effects were larger compared to low trust communities (Dussaillant and Guzman, 2014). Finally, research has found that community engagement principles helped elevate both preparedness for disasters and community trust (Paton, 2007). Given these mixed results, low trust may decrease willingness (and eventual action) to provide shared resources in disaster.

2.4 Compassion in Disasters

While low trust may reduce sharing, compassion may overcome this barrier and increase sharing behavior. Research has found that the human capacity for empathy spurred sentiments of pity or compassion, which led individuals to pursue humanitarian response (Carbonnier, 2015). Often, traumatic experiences have led to positive compassion changes to help form deeper relationships (Tedeschi and Calhoun, 1996). Other research found that community-based compassion through organizations has alleviated local victim suffering in disasters (Shepherd and Williams, 2014). Individuals also preferred policies that reflect compassion, which may be somewhat impacted by self-interest (Viscusi and Zeckhauser, 2006), and tended to be less compassionate for individuals who made high-risk decisions (i.e., knowingly living in a flood plain). Research has also found that empathy was predictive of the willingness to help but not predictive of actual actions to help victims (Marjanovic et al., 2012).

2.5 Key Literature Gaps

Despite considerable research on evacuation logistics, trust, and compassion, two key gaps remain. First, research on wildfire logistics remains sparse. Fisher III et al., (1995) interviewed evacuees from the Ephrata Fire, finding that most evacuees stayed with friends or family during the evacuation. For a hypothetical wildfire, Mozumder et al. (2008) found similar sheltering rates as hurricane evacuations (57% with friends and family, 29% in a hotel/motel, and 2% in a public shelter). However, with very few studies, the demand for evacuation resources (including transportation resources) remains largely unknown for wildfires. Second, research on why people may or may not be willing to share resources for evacuations is lacking. Wong et al. (2019) and Wong and Shaheen (2019) only provided descriptive statistics on the capacity and willingness to share. Neither of these studies nor Li et al. (2018) identified factors that impact willingness to share. Borowski and Stathopoulos (2020) focused on TNC mode choice using SP data from only non-evacuees, assessing the demand for shared resources but not the potential capacity. Moreover, based on the disaster literature, trust and compassion could be key variables that impact willingness. This paper seeks to fill these literature gaps.

3. METHODOLOGY

We developed an online survey to better understand the role of trust and compassion in disasters for the 2017 and 2018 California wildfires. In this section, we present the survey distribution method, scenario development, the discrete choice models, and study limitations.

3.1 Survey Distribution

We distributed two surveys to individuals impacted by the: 1) 2017 December Southern California Wildfires (n=226) from April to June 2018 and 2) 2018 Carr Wildfire (n=284) from February to April 2019. The 2017 December Southern California Wildfires (shortened to the 2017 Southern California Wildfires in this paper) were a destructive series of wildfires – primarily composed of the Thomas, Creek, Rye, and Skirball Fires – that led to mass evacuations. The Thomas Fire was one of the largest fires in California history, burning over 280,000 acres and destroying more than 1,000 structures (Cal Fire, 2018a). The Carr Fire in 2018 was a destructive fire in Redding, California that required thousands to evacuate, burned over 121,000 acres, and destroyed more than 1,500 buildings (Cal Fire, 2018b).

The survey was distributed online with the help of local partnering agencies and organizations. We first developed a list of potential partners including transportation, public transit, and emergency management agencies, news media, community-based organizations (CBOs) and non-governmental organizations (NGOs). Potential partners were contacted and asked to post the survey to online sources including Facebook, Twitter, listservs, alert subscription services, and websites. Participants were incentivized with the chance to win one of five $200 gift cards for the 2017 Southern California Wildfires and one of ten $250 gift cards for the Carr Fire. After removing unfinished surveys and cleaning based on key questions, we achieved a survey sample of 226 for the 2017 Southern California Wildfires and 284 for the 2018 Carr Wildfire. A more detailed description of the surveys can be found in Wong and Shaheen (2019).

3.2 Scenario Development

To better understand the potential for shared resources in evacuations and recovery efforts, we created four scenarios related to resource sharing in a future evacuation. The scenarios assess willingness to share resources and are the dependent variables in our discrete choice models to better understand the factors that impact this willingness:

- S1-Shelter-Cost: Sheltering – Individual's willingness to offer shelter to other evacuees at a cost per night
- S2-Shelter-Free: Sheltering – Individual's willingness to offer shelter to other evacuees for free
- S3-Transport-Before: Transportation – Individual's willingness to offer a ride to other evacuees before the evacuation process begins
- S4-Transport-During: Transportation – Individual's willingness to offer a ride to other evacuees during the evacuation, enroute to the destination.

These sharing scenarios follow the same pattern as Wong et al. (2018b) and were designed to address potential opportunities for sharing. The two sheltering scenarios were designed to test if potential profit for hosts impacted willingness to share. The two transportation scenarios differ by temporal impact, which is less relevant for sheltering. Our goal is to determine whether sharing transportation is more effective before or during an evacuation. We focused entirely on free transportation in contrast to profit-based transportation scenarios, which is a limitation of our design. All respondents answered questions regarding each of the sheltering scenarios, while only evacuees answered the transportation scenarios. The individual(s) receiving assistance was not specified beyond "individual(s)." The scenarios asked for willingness on a scale with five options:

1) extremely likely, 2) moderately likely, 3) neither likely nor unlikely, 4) moderately unlikely, and 5) extremely unlikely.

3.3 Discrete Choice Models

We developed eight binary logit models to assess willingness to share, following the methodology of Ben-Akiva and Lerman (1985). For the analysis, we divided the "choice" of willingness to share into a binary decision: 1) extremely likely to share and 2) all other answers. This was chosen to better isolate individuals who would realistically share in a future disaster (i.e., stated willingness of extremely likely), which is why we did not estimate an ordered logit or probit model. In our paper, we wanted to develop a distinction between people who would be extremely likely to share and those who would be moderately willing to share. We also tested several models taking advantage of heterogeneous parameters through a mixed logit model. We found strong insignificance of almost all random parameters, which is likely due to a single observation per individual. We estimated the binary logit models using the Python package *Pylogit* (Brathwaite and Walker, 2018). The binary logit models are presented emphasizing each of the following variable types: 1) trust and compassion; 2) demographic variables; 3) evacuation circumstances, and 4) urgency indicators. Urgency indicators are characteristics of the evacuation (specifically departure time and route choice) that highlight the stressful and difficult choice context in a disaster. This includes characteristics of the hazard (e.g., fire threat) and choice alternatives (e.g., police presence). We selected variables following recommendations in Ben-Akiva and Lerman (1985), consisting of variables that are significant, behaviorally important, and/or a correct *a priori* coefficient sign. We note that in several instances we retained some non-significant variables since they were behaviorally important with the correct *a priori* coefficient sign. The decision to retain insignificant variables, while less efficient, decreases bias in our results. We also conducted a sample enumeration for each scenario by setting all responses for trust and compassion variables to be one or zero, thus mirroring a highly trustful sample and very distrustful sample. This is supplemented by probability weighted cross tabulations of sharing choice and reservations to find potential differences in sharing concerns.

3.4 Study Limitations

It is important to note that our study design has several limitations. First, our survey has a self-selection bias, since respondents opted into the study. The online survey also only reached individuals with Internet access, causing significant under sampling of technology non-users. This undersampling, while not problematic for modeling willingness to share, likely causes an overestimation of sharing resource capacity. We attempted to reduce these limitations by distributing the survey across multiple agencies with varying captured populations. We also received assistance from local CBOs and news organizations to distribute the surveys more broadly. To reduce self-selection and non-response bias, we also offered an incentive via a random drawing. Incentives are designed to encourage higher response across the general population, who may be less likely to participate in an incentive-absent survey compared to captive individuals with a high interest in the topic. Still, both survey samples skew female, white, higher income, higher education, and higher vehicle ownership. Consequently, this likely overestimates the available capacity of sharing economy resources. This sampling limitation also prevents us from knowing how vulnerable populations make choices. Indeed, willingness to share is likely overestimated, as those without vehicle access (who were under sampled) are unable to provide

transportation in disasters. In our case, vulnerable populations could be either providers or users of shared resources.

We also recognize that some limitations exist in the design of the survey instrument, which included over 150 questions and may have led to severe survey fatigue. For the sharing economy questions, respondents may not have been able to conceptualize sharing resources in a disaster or during recovery efforts. While we asked respondents about their evacuation experience, characteristics of their choices, and sociodemographics, we did not ask respondents about their social networks. The strength of social networks could be a key indicator for sharing willingness. We asked respondents about their social connections via community groups and volunteering, which serve as reasonable proxies for social networks.

We note several modeling limitations with our chosen binary structure. We attempted to model choice through several multinomial choice structures but found that the most distinctive difference in behavior was between extremely likely sharers and all other responses. However, a future research direction would be to take advantage of the ordering of responses for an ordered logit/probit model. Moreover, the choices in these scenarios are likely to be correlated. Given this potential correlation structure, future research could also attempt to model these choices jointly, taking advantage of nested, portfolio choice, or latent class choice models to determine any potential joint preferences. We also did not find any benefit in a mixed logit formulation. This negative result may not appear in other datasets and should continue to be tested in other situations.

Finally, we acknowledge that the sharing economy is just one tool for evacuating individuals and would likely be a small fraction of mode and shelter choices. However, we stress that any tool that could increase the amount of resources available in evacuations deserves exploration, especially if these resources increase compliance, decrease congestion, and ensure more equitable evacuations.

4. RESULTS/DISCUSSION

4.1 Wildfire Logistics

We first provide the demographic characteristics of the respondents (see Table 1 below) and wildfire logistic results for both wildfires (see Table 2 below). We find that most individuals evacuated from both samples with low non-compliance rates (i.e., receiving a mandatory evacuation order but not evacuating). Shadow evacuation rates (i.e., not receiving a mandatory evacuation order but still evacuating) were high, most likely a result of poor communication throughout both wildfires. Evacuation travel times were concentrated between 30 minutes and several hours, suggesting short-distance evacuations. This is confirmed by destination choice: approximately two-thirds of respondents from both wildfires remained within county.

TABLE 1. Demographic Characteristics of Survey Respondents

	2017 Southern California Wildfires	**2018 Carr Wildfire**
Individual Characteristics	*n=226*	*n=284*
Gender		
Male	26.1%	30.3%
Female	73.9%	69.7%
Age		
18-24	2.7%	2.8%

25-34	17.7%	12.7%
35-44	15.0%	19.0%
45-54	19.0%	22.9%
55-65	26.5%	19.7%
65+	19.0%	22.9%
Race		
Asian	2.7%	1.1%
Black or African American	0.4%	0.0%
Mixed	7.5%	3.5%
Native American/Alaska Native	0.4%	1.4%
Pacific Islander	0.9%	0.0%
White	81.4%	90.8%
Other	4.0%	0.0%
Prefer not to answer	2.7%	3.2%
Ethnicity		
Hispanic	11.1%	5.3%
Not Hispanic	76.1%	87.3%
Prefer not to answer	8.8%	7.4%
Education		
Less than high school	0.0%	0.7%
High school graduate	0.9%	4.9%
Some college	15.9%	23.2%
2-year degree	5.8%	12.0%
4-year degree	41.2%	27.8%
Professional degree	28.3%	27.5%
Doctorate	8.0%	3.9%
Prefer not to answer	0.0%	0.0%
Employment		
Employed full time	57.1%	47.9%
Employed part time	11.9%	10.9%
Unemployed looking for work	2.2%	2.8%
Unemployed not looking for work	2.7%	4.2%
Retired	22.1%	26.1%
Student	2.2%	1.8%
Disabled	1.3%	2.8%
Prefer not to answer	0.4%	3.5%
Primary Mode of Transportation		
Drive alone using a car, SUV, pickup, or van	87.6%	92.6%
Carpool/vanpool	2.2%	1.4%
Rail (e.g., light/heavy, subway/metro, trolley)	0.9%	0.0%
Bus	1.8%	0.0%
Motorcycle/scooter	0.9%	0.4%
Bicycle	0.9%	0.7%
Walk	0.4%	0.0%
Shuttle service	0.0%	0.4%
Work from home	1.8%	1.4%
Other	0.9%	2.8%
Prefer not to answer/No answer	2.7%	0.4%
Previous Evacuee		
Yes	35.3%	31.0%

No	64.7%	69.0%
Previous Wildfire Experience		
Yes	93.4%	89.1%
No	6.6%	10.9%
Mobile Phone Type		
Do not own a mobile phone	2.7%	3.2%
Own a typical mobile phone (non-smartphone)	5.3%	3.9%
Own a smartphone	92.0%	93.0%
Access to Internet at Home		
Yes	98.7%	97.2%
No	1.3%	2.8%
In-Vehicle or Smartphone Navigation		
Yes	79.6%	78.2%
No	20.4%	21.8%
Household Characteristics	*n=226*	*n=284*
Displacement after Wildfire		
Same Residence	88.9%	87.0%
Displaced	10.6%	13.0%
No answer	0.4%	0.0%
Length of Residence		
Less than 6 months	5.8%	3.2%
6 to 11 months	4.9%	5.3%
1 to 2 years	12.4%	13.7%
3 to 4 years	14.6%	9.5%
5 to 6 years	7.1%	7.7%
7 to 8 years	5.3%	5.3%
9 to 10 years	4.9%	6.0%
More than 10 years	45.1%	49.3%
Residence Structure		
Site build (single home)	73.9%	91.2%
Site build (apartment)	19.5%	4.2%
Mobile/manufactured home	6.2%	4.6%
Prefer not to answer	0.4%	0.0%
Homeownership		
Yes	67.3%	81.3%
No	29.6%	17.3%
Prefer not to answer	3.1%	1.4%
Live in Cal Fire High Risk Area		
Yes	38.1%	37.7%
No	28.8%	35.2%
I don’t know	33.2%	27.1%
Household Characteristics		
Household with Disabled	14.2%	18.7%
Household with Children	25.2%	35.2%
Household with Elderly	28.3%	31.3%

Households with Pets	63.7%	81.7%
Household Income		
Less than $10,000	0.4%	0.7%
$10,000 - $14,999	1.3%	3.9%
$15,000 - $24,999	2.2%	2.8%
$25,000 - $34,999	2.2%	5.6%
$35,000 - $49,999	6.2%	9.5%
$50,000 - $74,999	14.6%	17.6%
$75,000 - $99,999	11.5%	14.8%
$100,000 - $149,999	21.2%	19.7%
$150,000 - $199,999	13.3%	5.6%
More than $200,000	14.2%	8.1%
Prefer not to answer	12.8%	11.6%
County of Residence	*n=226*	*n=284*
Ventura	43.8%	
Santa Barbara	41.6%	
Los Angeles	13.3%	
Other California	1.3%	
Shasta		94.0%
Other California		2.5%
Non-California		3.5%

Note: Percentages may not add to 100% due to rounding

TABLE 2. Key Evacuation Logistics and Choices

	2017 Southern California Wildfires	**2018 Carr Wildfire**
All Respondents	*n=226*	*n=284*
Evacuation Choice		
Evacuated	77.4%	89.4%
Did Not Evacuate	22.6%	10.6%
Received Mandatory Evacuation Order		
Yes	61.1%	66.2%
No	38.9%	33.8%
Non-Compliance Rate *(out of individuals who received a mandatory order)*	13.0% *(n=138)*	3.2% *(n=188)*
Shadow Evacuation Rate *(out of individuals who did not receive a mandatory order)*	62.5% *(n=88)*	75.0% *(n=96)*
Evacuees Only	*n=175*	*n=254*
Departure Timing by Hour		
12:00 AM – 5:59 AM	22.9%	9.1%
6:00 AM – 11:59 AM	19.4%	7.9%
12:00 PM – 5:59 PM	20.0%	19.7%
6:00 PM – 11:59 PM	14.9%	63.4%
Evacuation Travel Time		
Less than 30 min.	13.1%	5.1%

30 min. – 59 min.	25.7%	24.0%
1-1.99 hours	22.9%	23.2%
2-2.99 hours	13.7%	17.3%
3-3.99 hours	6.3%	10.2%
4-4.99 hours	6.9%	5.1%
5-9.99 hours	6.3%	6.3%
10 hours or more	5.1%	7.9%
No answer	0.0%	0.8%
Mode Choice		
One personal vehicle	45.1%	33.9%
Two personal vehicles	40.6%	45.3%
More than two personal vehicles	8.6%	16.5%
Aircraft	0.6%	0.0%
Rental car	0.6%	0.0%
Recreational vehicle (RV)	1.1%	2.4%
Truck and trailer	2.3%	0.0%
Non-household carpool	1.1%	1.2%
Carsharing	0.0%	0.4%
Walk	0.0%	0.4%
Open Seats with Seatbelts in Evacuating Vehicles		
0	29.7%	24.8%
1	6.3%	6.7%
2	14.3%	9.8%
3	13.7%	12.6%
4	11.4%	8.7%
5 or more	24.6%	37.4%
Primary Route by Road Type		
Highways	62.3%	39.4%
Major Roads	15.4%	17.5%
Local Roads	4.0%	4.9%
Rural Roads	1.1%	4.9%
No Majority Type	17.1%	36.6%
Usage of GPS for Routing		
Yes, and followed route	18.3%	7.5%
Yes, but rarely followed route	4.6%	5.5%
No	77.1%	87.0%
Shelter Type		
A friend's residence	30.3%	39.8%
A family member's residence	32.6%	29.9%
A hotel or motel	22.9%	13.4%
A public shelter	3.4%	2.4%
A second residence	2.9%	3.1%
A portable vehicle (e.g., camper, RV)	4.0%	5.1%
Peer-to-peer service (e.g., Airbnb)	1.1%	0.4%
Other	2.9%	5.9%
Multiple Destinations		
Yes	41.7%	48.4%
No	58.3%	51.6%
Within County Evacuation		

Yes	66.3%	66.1%
No	33.7%	33.9%
Length Away from Home		
Less than 1 day	4.6%	1.2%
1-2 days	22.9%	11.8%
3-4 days	24.6%	18.1%
5-6 days	14.3%	22.8%
7-8 days	7.4%	23.2%
9-10 days	5.7%	7.1%
11-14 days	9.1%	3.9%
15-21 days	4.6%	4.3%
More than 21 days	6.9%	7.5%
Returned Home		
Yes	92.6%	96.9%
No	7.4%	3.1%

Note: Percentages may not add to 100% due to rounding

For mode choice, we find most respondents use one vehicle (33.9% to 45.1%) or two vehicles (40.6% to 45.3%) to evacuate. The Carr Wildfire had a higher number of evacuating vehicles, perhaps due to auto dependency in the Redding area. With a significant number of multi-vehicle evacuations, 64.0% and 68.5% of respondents had at least two spare seatbelts for the 2017 Southern California Wildfires and Carr Wildfire, respectively. For shelter choice, most respondents stayed with family or friends, which mirrors hurricane literature (Lindell et al., 2019). Hotels and motels were also popular, but under 4% stayed at a public shelter. Almost no participants found a shelter through a peer-to-peer service. A significant number of respondents also sheltered at more than one destination, suggesting shifting fire danger or inadequate long-term sheltering. Finally, most respondents did not use GPS while evacuating, suggesting that evacuees relied on their own experience or directions from officials.

4.2 Trust, Compassion, and Volunteerism

Next, we provide descriptive statistics on respondents' trust, compassion and volunteerism (see Table 3 below), finding similar results between the wildfires. While individuals trusted most people, the level of trust differs by group. Family and friends ranked the highest, followed by coworkers. Average trust (from a Likert scale of 1 to 5) of neighbors (m = 3.61 and m = 3.80) ranked slightly higher than trust of community members and individuals from other cities. Higher trust of neighbors and closer connections suggests focusing on these social networks for sharing resources. One difference was that respondents from the Southern California Wildfires had a higher trust of strangers (m = 3.50) than respondents from the Carr Wildfire (m = 3.00), indicating potential differences in sharing levels with strangers. Most respondents for both wildfires also perceived an increase in trust in the community following the wildfires, indicating the trust-building nature of disasters. Indeed, individuals who received assistance from neighbors and had strong personal networks experienced faster disaster recovery (Sadri et al., 2018).

TABLE 3. Trust, Compassion, and Volunteerism

	2017 Southern California Wildfires	2018 Carr Wildfire
Sample Size	*226*	*284*
General Trust of Most People		
Yes, it is possible to trust most people	68.6%	63.7%
No, we can never be too cautious	29.2%	36.3%
No answer	2.2%	0.00%
Change in Trust of Others in Community Following Wildfires		
Increased substantially	23.9%	20.1%
Increased moderately	30.1%	41.2%
Remained the same	39.8%	32.4%
Decreased moderately	3.5%	4.2%
Decreased substantially	0.4%	2.1%
No answer	2.2%	0.0%
Past Disaster Volunteer		
Yes	36.7%	33.5%
No	61.9%	66.5%
No answer	1.3%	0.0%
Volunteer for Wildfires		
Yes	44.2%	46.8%
No	54.9%	53.2%
No answer	0.9%	0.0%
Mean Trust of Groups of People (Out of 5)		
Family	4.66	4.61
Friends	4.35	4.48
Coworkers	4.02	3.95
Neighbors	3.61	3.80
Other Neighborhoods in Community	3.29	3.56
Other Cities	3.10	3.21
Strangers	3.50	3.00
Bus Drivers	3.60	3.64
Lyft/Uber Drivers	3.41	3.27
Taxi Drivers	2.37	3.20
Police	3.77	3.95
Government	3.62	3.56
Mean Compassion (Out of 5)		
General Compassion (GC)	4.20	4.14
Stranger Compassion (SC)	3.97	4.04
Helping Compassion (HC)	3.60	3.80
Not-Selfish Compassion (NSC)	3.57	3.40
Tender Compassion (TC)	2.62	3.82

GC: When I hear about someone (a stranger) going through a difficult time, I feel a great deal of compassion for him or her.
SC: I tend to feel compassion for people, even though I do not know them.
HC: One of the activities that provides me with the most meaning to my life is helping others in the world when they need help.
NSC: I would rather engage in actions that help others, even though they are strangers, than engage in actions that would help me.
TC: I often have tender feelings toward people (strangers) when they seem to be in need.

Note: Percentages may not add to 100% due to rounding.

About one-third of wildfire respondents were a past disaster volunteer, indicating strong networks to provide support. Moreover, around 45% of respondents were volunteers for the wildfires, revealing significant outpouring from the community for others. For compassion, we found similar average levels between the wildfires, except for tender compassion (i.e., tender feelings for strangers in need). In addition, non-selfish compassion (i.e., engaging in activities to help strangers before self-serving activities) had a low average score, but this could still impact willingness to share.

4.3 Concerns About Sharing

We also asked respondents about reservations they had with sharing resources in an evacuation (Table 4). These questions were asked in the context of the shared resource scenarios for both transportation and sheltering. We found that concerns were very similar between the two datasets. Uncertainty about one's own safety and security was the largest concern for sheltering, followed by feeling responsible for additional house guest(s), disruption to everyday tasks, and having to interact with a stranger. These results indicate that potential hosts place high value in safety and liability, perhaps requiring a formalized system of matching to overcome these concerns. However, individuals were not concerned that a sharing strategy would not have government oversight, suggesting that a strategy could be carried out by NGOs, CBOs, and/or private companies.

For transportation, safety and security was still a major concern, but respondents were also highly worried about not having enough vehicle space for the additional passenger(s) belongings and adding extra time to the evacuation. These concerns were more prominent for the 2017 Southern California wildfires, which may reflect some geographical and cultural differences. Reservations about vehicle space could significantly hamper a sharing strategy, especially since vehicle "guest" passengers would be unlikely to split their households into different vehicles. Further, concerns about adding extra time could require dedicated pickup locations to ensure that drivers do not have to deviate far from their planned evacuation route. Indeed, evacuation route deviation was expressed as a concern by around one-third of participants. Feeling responsible for passengers was also a key concern for transportation. We note that having to interact with a stranger was much less of a reservation for transportation, suggesting a shared mobility strategy among private citizens may be more feasible in evacuations than a shared housing strategy.

TABLE 4. Concerns about Sharing Sheltering and Transportation in an Evacuation and During Recovery

Reservations of the Sharing Economy *(Top Four Reservations Highlighted)*	**2017 Southern California Wildfires**	**2018 Carr Wildfire**
Reservations About Sheltering an Evacuee (Full Sample)	*n = 226*	*n = 284*
Uncertainty about one's own safety or security	55.3%	57.4%
Feeling responsible for the additional house guest(s)	48.7%	45.1%
Disruption of everyday tasks	42.0%	37.3%
Having to interact with a stranger	40.7%	35.9%
Not enough space for the additional guest(s)' belongings	29.6%	29.6%
General dislike of hosting	21.2%	20.4%
Having to drive the individuals around	12.8%	16.5%
Not having enough water and/or food	24.8%	24.3%
No government oversight	5.3%	3.9%
I do not have concerns/reservations	4.0%	9.5%
Concerns About Transporting an Evacuee (Evacuees Only)	*n = 175*	*n = 254*
Uncertainty about one's own safety or security	44.6%	48.4%
Feeling responsible for the additional passenger(s)	44.6%	25.6%
Not enough space for the additional passenger(s)' belongings	53.7%	42.9%
Adding extra time to the evacuation	56.6%	45.7%
Having to deviate from the evacuation route	39.4%	31.9%
Having to interact with a stranger	25.7%	16.9%
Having to drive evacuee(s) for a long period of time	22.3%	13.0%
Not having enough fuel	18.3%	16.1%
Not having enough water and/or food	8.0%	6.3%
I do not have any concerns/reservations	6.9%	13.0%
No government oversight	6.3%	1.2%

4.4 Willingness to Share Resources

In this section, we present modeling results for the willingness to share resources, which are organized by wildfire and by sharing sector (i.e., shelter and transportation).

4.4.1 2017 Southern California Wildfires – Shelter

We found for the 2017 Southern California Wildfires that individuals were more willing to share housing for free (24.3% extremely likely) than at a cost (11.5% extremely likely). See Table 5 below. From modeling, trust and compassion variables were positive and significant for both S1-Shelter-Cost and S2-Shelter-Free. Those who perceived increases in community trust were more likely to share shelter, suggesting that newly established trust can increase resources. Young adults and lower-income households were more likely to share for S1-Shelter-Cost, perhaps due to

familiarity with priced home sharing and possible monetary benefits. However, females and smaller households were less likely to share. For S2-Shelter-Free, families were less likely to share, perhaps due to safety concerns. Long-term residents and smaller households were also less likely share. Smaller households may have less space for an evacuee (including fewer available bedrooms). It is not readily clear why long-term residents were less likely to share, but the result may be related to a lack of trust of newcomers into their neighborhood. Spare capacity was positive for both S1-Shelter-Cost and S2-Shelter-Free but not significant, highlighting the more powerful role of trust and compassion in willingness to share.

4.4.2 2017 Southern California Wildfires – Transportation

Compared to sheltering, individuals were significantly more likely to share transportation overall but also more so while evacuating (58.9%) than before evacuation (36.6%). In Table 5, we found that trust of neighbors was positive and significant for both S3-Transport-Before and S4-Transport-During, suggesting that neighbor-based resource pooling may be most effective. High tender compassion was also positive and significant for both scenarios, indicating high concern for others' welfare. Individuals who were part of a community organization were somewhat more likely to share for S3-Transport-Before, while past volunteerism increased willingness for both scenarios. Those with older adults in their household were also more likely to share, perhaps due to their knowledge of the evacuation needs of vulnerable populations. Again, long-term residents were less likely to share. In this case, these individuals may have conducted more pre-evacuation trips to prepare their property and gather supplies. Previous evacuees and lower-income households were less likely to share during the evacuation, perhaps due to past poor evacuation experiences and resource constraints, respectively. Those living in Ventura County were much more likely to share transportation during, perhaps due to the higher level of urgency during the Thomas Fire. For evacuation circumstances, sheltering with a friend increased willingness for S3-Transport-During. Evacuation circumstances increased willingness for S4-Transport-During, including spare seatbelts and receiving a mandatory evacuation order. Mandatory orders could be potential mechanisms to increase sharing by notifying evacuees of transportation needs in their community. Urgency indicators were also important, specifically the higher pressure from officials to leave and the high presence of police along the route adding to increased willingness. As such, officials, police, and other first responders may present a strategy for communicating resource needs to private individuals and encouraging sharing. We note that police presence is classified under urgency since law enforcement typically provides mandatory evacuation orders and/or traffic orders that are based on the current hazard situation.

4.4.3 2018 Carr Wildfire – Shelter

We found 14.1% and 29.6% were extremely likely to share for S1-Shelter-Cost and S2-Shelter-Free, respectively, for the Carr Wildfire. We found positive and significant variables for trust and compassion, with an emphasis on trust of strangers and non-selfish compassion (see Table 6 below). For S1-Shelter-Cost, previous volunteers and members of community groups were more likely to share, indicating a potential avenue for a shared resource network. High-income households ($100,000 and above) were less likely to share for a cost, likely due to their lower need for additional funding. Households with spare beds and previous evacuees were more willing to share, but the variables were slightly insignificant. For S2-Shelter-Free, smaller households were more likely to share, which differs from the 2017 Southern California Wildfires models. This

difference is not readily clear, but it could be related to the cheaper housing stock in the Redding area by square footage. Smaller households may still have spare bedrooms for evacuees. Other demographic characteristics for both sheltering scenarios were not significant but exhibited correct signs.

4.4.4 2018 Carr Wildfire – Transportation

Respondents were extremely willing to share for S3-Transport-Before (48.4%) and S4-Transport-During (72.0%). Trust of strangers was significant and positive for S3-Tranport-Before, while overall trust impacted S4-Transport-During (Table 6). High non-selfish compassion was positive and significant for both scenarios, and high overall compassion was significant for S4-Transport-During. Most demographic variables were weak influencers except for households with children, who were much less likely to share for both scenarios. Young adults were less likely to share during the evacuation, which may be related to less experience driving during an evacuation. Interestingly, being part of an organization (e.g., arts/cultural, education/school/PTA, professional/trade, religious, social service/charitable) was negative for S3-Transport-Before, albeit somewhat insignificant. This finding runs counter to our other models. One possible explanation is that Redding community organizations were highly active before the evacuations, and individuals would be unavailable to transport others. Homeowners were less likely to share for S4-Transport-During, perhaps because they wanted to defend their home and evacuate later. Spare capacity (i.e., more than three spare seatbelts) was positive for both scenarios but only significant for S4-Transport-During. For S3-Transport-Before, individuals who did not have any pre-evacuation trips were more likely to share, since they had more time to assist. However, individuals who stayed with family were much less likely to share. Interestingly, those who received a mandatory evacuation order were less likely to share. This was likely because they had little time to consider helping others before evacuating themselves. We also found urgency variables – high visual fire levels, high smoke, low visibility, and high traffic – to be positive and almost all significant for S3-Transport-Before. Very high fire danger and police presence was positive for S4-Transport-During, while the high presence of first responders was negative. These urgency variables suggest that disaster risk may trigger sharing, increasing empathy and concern for other evacuees.

TABLE 5. Estimation Results for Sharing Scenarios for the 2017 Southern California Wildfires

Choice 1: Extremely Likely to Share in a Future Disaster

Choice 2: Somewhat Likely, Neither Likely nor Unlikely, Somewhat Unlikely, or Extremely Unlikely to Share in a Future Disaster

	S1-Shelter-Cost			**S2-Shelter-Free**			**S3-Transport-Before**			**S4-Transport-During**		
Survey Results: Extremely Likely to Share in a Future Disaster	**11.5%**			**24.3%**			**36.6%**			**58.9%**		
Variables	**Coef.**	**p-value**		**Coef.**	**p-value**		**Coef.**	**p-value**		**Coef.**	**p-value**	
Constant Share	-3.91	<0.01	***	-1.45	0.05	*	-2.69	<0.01	***	-1.25	0.02	*
Trust and Compassion												
High Trust of Friends	1.58	0.01	**	------	------		------	------		------	------	
High Trust of Neighbors	------	------		0.89	0.04	*	0.95	0.04	*	1.25	0.02	*
Perception of Substantial Increase in Community Trust	1.58	<0.01	***	1.04	0.01	**	------	------		------	------	
High Non-Selfish Compassion	1.04	0.08	†	------	------		------	------		------	------	
High Helping Compassion	------	------		0.78	0.03	*	------	------		------	------	
High Tender Compassion	------	------		------	------		1.29	<0.01	***	0.66	0.13	
Demographics												
Young Adult (Under 35)	1.03	0.05	*	------	------		------	------		------	------	
Female	-0.80	0.11		------	------		------	------		------	------	
Part of Organization	------	------		0.42	0.36		0.47	0.29		------	------	
Volunteer in Past	------	------		------	------		0.51	0.17		0.92	0.02	*
Used Homesharing Before	1.15	0.22		------	------		------	------		------	------	

Previously Experienced a Wildfire	------	------		------	------		0.69	0.35		------	------	
Previous Evacuee	------	------		------	------		------	------		-0.62	0.10	†
1- and 2-Person Household	-0.68	0.16		-1.09	0.02	*	0.40	0.29		------	------	
Household Income Under $50,000	1.15	0.09	†	------	------		------	------		-0.69	0.21	
Children Present in Household	------	------		-1.58	0.01	**	------	------		------	------	
More than 10 Years in Residence	------	------		-0.89	0.02	*	-0.76	0.04	*	------	------	
Older Adult(s) Present in Household	------	------		------	------		0.76	0.06	†	------	------	
Resident of Ventura County	------	------		------	------		------	------		1.13	<0.01	***
Any Spare Beds	0.62	0.42		0.56	0.28		------	------		------	------	
Evacuation Circumstances												
Received Mandatory Evacuation Order	------	------		0.36	0.32		------	------		0.43	0.26	
Any Spare Seatbelts	------	------		------	------		------	------		0.66	0.09	†
Shelter Choice - Friends	------	------		------	------		0.54	0.16		------	------	
Urgency Variables												
Very High Official Pressure to Leave	------	------		------	------		0.50	0.23		------	------	
Very High Presence of Police	------	------		------	------		------	------		1.44	0.02	*
Extremely Likely to Share: *Sample Enumeration – All High Trust and Compassion Dummy Values = 0*	2.5%			14.8%			26.8%			52.0%		
Extremely Likely to Share: *Sample Enumeration – All High Trust and Compassion Dummy Values = 1*	53.8%			67.6%			73.6%			84.7%		
Observations	226			226			175			175		
R-Squared	0.60			0.29			0.17			0.18		
Adjusted R-Squared	0.53			0.23			0.08			0.10		

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TABLE 6. Estimation Results for Sharing Scenarios for 2018 Carr Fire

Choice 1: Extremely Likely to Share in a Future Disaster

Choice 2: Somewhat Likely, Neither Likely nor Unlikely, Somewhat Unlikely, or Extremely Unlikely to Share in a Future Disaster

	S1-Shelter-Cost			**S2-Shelter-Free**			**S3-Transport-Before**			**S4-Transport-During**		
Survey Results: Extremely Likely to Share in a Future Disaster	**14.1%**			**29.6%**			**48.4%**			**72.0%**		
Variables	**Coef.**	**p-value**		**Coef.**	**p-value**		**Coef.**	**p-value**		**Coef.**	**p-value**	
Constant Share	-5.36	<0.01	***	-2.04	0.01	**	-0.25	0.64		1.05	0.17	
Trust and Compassion												
Moderate and High Trust of Strangers	1.14	0.01	**	0.59	0.09	†	0.70	0.07	†	------	------	
High Trust of Neighbors	0.57	0.18		------	------		------	------		------	------	
High Trust Overall	------	------		------	------		------	------		0.72	0.03	*
High Non-Selfish Compassion	0.93	0.03	*	1.98	<0.01	***	1.36	<0.01	***	1.68	0.02	*
High Overall Compassion	------	------		------	------		------	------		0.60	0.09	†
Demographics												
Young Adult (Under 35)	------	------		------	------		------	------		-0.88	0.05	*
White	------	------		-0.48	0.30		------	------		------	------	
Volunteer in Past Disaster	0.76	0.05	*	0.26	0.38		------	------		------	------	
Part of an Organization	1.02	0.06	†	------	------		-0.40	0.22		------	------	
Previously Experienced a Wildfire	------	------		------	------		------	------		-0.59	0.30	
Previous Evacuee	-0.47	0.25		------	------		-0.46	0.14		------	------	
1 and 2 Person Household	------	------		0.99	0.02	*	------	------		------	------	
Children Present in Household	------	------		0.40	0.37		-0.79	0.02	*	-0.73	0.03	*
Residence - Single Family Home	0.81	0.32		------	------		------	------		------	------	
Homeowner	------	------		------	------		------	------		-0.82	0.07	†
Household Income $100,000 and Above	-0.83	0.05	*	0.27	0.39		0.44	0.18		------	------	
Any Spare Beds	1.68	0.12		0.29	0.59		------	------		------	------	

Evacuation Circumstances										
Received Mandatory Evacuation Order	------	------	------	------	-0.73	0.03	*	------	------	
More than 3 Spare Seatbelts	------	------	------	------	0.28	0.38		0.91	0.01	**
0 Trips Before Evacuating	------	------	------	------	0.67	0.05	*	------	------	
Items to Tow	------	------	------	------	0.53	0.17		------	------	
Shelter Choice - Family	------	------	------	------	-1.18	<0.01	***	------	------	
Shelter Choice - Friends	------	------	------	------	------	------		0.63	0.06	†
Urgency Variables										
Very High Visual Fire Level	------	------	------	------	0.38	0.20		------	------	
Very High Smoke Level	------	------	------	------	0.82	0.01	**	------	------	
Very Low Visibility	------	------	------	------	1.37	0.04	*	------	------	
Very High Traffic Levels	------	------	------	------	0.58	0.06	†	------	------	
Very High Fire Danger Level on Route	------	------	------	------	------	------		0.88	0.08	†
Very High Presence of First Responders	------	------	------	------	------	------		-1.39	0.02	*
Very High Presence of Police	------	------	------	------	------	------		1.24	0.06	†
Extremely Likely to Share: *Sample Enumeration – All High Trust and Compassion Dummy Values = 0*	8.3%		20.8%		41.9%			55.1%		
Extremely Likely to Share: *Sample Enumeration – All High Trust and Compassion Dummy Values = 1*	48.5%		75.6%		79.1%			94.7%		
Observations	284		284		254			254		
R-Squared	0.52		0.24		0.19			0.3		
Adjusted R-Squared	0.47		0.19		0.1			0.22		

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4.4 Willingness to Share: Key Takeaways

In the DCA analysis, we found a nuanced story among sharing scenarios and between the two sets of wildfires in 2017 and 2018. We found trust and compassion variables greatly increased willingness to share, particularly trust of strangers, trust of neighbors, and non-selfish compassion. Demographic variable influence was scattered across scenarios and wildfires with four notable exceptions. Volunteers in past disasters and members of community organizations were usually more likely to share, except for members of organizations (e.g., arts/cultural, education/school/PTA, professional/trade, religious, social service/charitable) who were less likely to share transportation before evacuating for the Carr Fire. On the other hand, previous evacuees and families were less likely to share, except for families interested in sharing their housing at no cost to evacuees for the Carr Fire.

We found some weak indication that higher-income households were more likely to share, except for sharing shelter for a cost (vs. sharing for free). We determined that long-term residents were less likely to share for the Southern California Wildfires (but not the Carr Fire), which may be tied to cultural differences between the impacted areas. The modeling results also indicated that most demographic variables were only significant for one or two scenarios (e.g., young adults, female, white, used homesharing before, older adults present in the household, homeowner, single family home residence). While demographics will differ by geography, these variables help pinpoint potential provider groups for a more generalized sharing strategy. We also tested a number of other demographic variables across all four scenarios (e.g., education, employment status, TNC experience, etc.) but found little significance. These results run contrary to our hypotheses and point to the greater importance of individual levels of trust and compassion for resource sharing.

Several evacuation circumstances were significant for some of the transportation scenarios (i.e., receiving a mandatory evacuation orders, number of trips prior to evacuating, shelter/accommodation choice during the wildfires). Spare capacity was sometimes significant in increasing willingness to share (especially for spare seatbelts), but we found that the variable for spare beds was largely insignificant. Spare capacity may be a prerequisite for sharing, but social variables may activate sharing behavior. Finally, we found several urgency variables for departure timing and routing impacted some transportation scenarios. Evacuees may realize that other neighbors need significant help and would perish without receiving transportation, indicating that sharing behavior is triggered by the urgency of disasters. Urgency variable were particularly important for the Carr Fire, suggesting that hazard and cultural characteristics may influence the degree to which urgency impacts sharing willingness.

Across the scenarios, we found similar models fits, except for sharing shelter at a cost. This is likely due to the very strong negative constant value, but this could also result from overfitting a smaller sample. We also conducted a brief sample enumeration for likelihood to share by transforming all trust and compassion variables into zeros (i.e., no respondents have high trust or compassion) and ones (i.e., all respondents have high trust or compassion). We found a significant range between a low trust/compassion population and a high trust/compassion population (between 30% and 55% difference depending on scenario), suggesting that very low trust/compassion communities and very high trust/compassion communities will have significantly different likelihoods (and eventual action) to share. Finally, the modeling results indicate that the four sharing scenarios produce unique behaviors that are not necessarily consistent. While it may be easier to construct a general framework that applies to sharing across these scenarios, the results suggest that the characteristics of the scenarios play an important role in willingness to share.

4.5 Concerns for Sharers and Non-Sharers

To supplement our understanding of the DCA results, we also conducted a weighted sample aggregation by the different reservations for sheltering and transporting an evacuee. For this analysis, we used the prediction probabilities calculated for each model and the individual results for each concern/reservation. The result is a weighted percentage of sharers and non-sharers who stated they had reservations about sharing resources (Table 7 and 8). While this cross tabulation by sharing choice and concern/reservation could have been conducted without our models, we note that the choice probabilities now factor in the different independent variables that influence sharing choice. Consequently, these probabilities are a consistent estimate of the number of sharers and non-sharers for each concern/reservation (see Train, 2002 for more on aggregation).

We found that across the sheltering scenarios for both wildfires, more non-sharers had concerns/reservations regarding sharing housing than sharers. While this was expected, we found especially high divergence between sharers and non-sharers for uncertainty about safety and security, feeling responsible for the evacuee, and disruption of everyday tasks. Overall, the sharers for the S2-Shelter-Free scenario had more reservations than sharers for the S1-Shelter-Cost scenario. This result is likely due to the higher percentage of individuals who were willing to share in the S2-Shelter-Free scenario. This indicates that concerns/reservations do not remain constant or decrease even as willingness increases, suggesting that sharers are still highly worried about aspects of sharing in an evacuation. Between each of the wildfires, we found that sheltering sharers had similar concern/reservation levels. However, the Carr Wildfire non-sharers generally had fewer concerns/reservations for both sheltering scenarios than the Southern California Wildfire non-sharers. This difference mirrors the concern/reservation results presented in Table 4 and is likely due to cultural differences and/or wildfire context differences. We note that the separation between wildfires is not enough to make any concrete conclusions, suggesting fairly strong consistency in reservations.

For transportation, we found that more non-sharers had concerns/reservations than sharers for S3-Transport-Before for both wildfires. However, we found that sharers had more concerns/reservations than non-sharers for S4-Transportation-During. This result is impacted by two factors: 1) high predicted choice probabilities for sharers in the DCA models, which influences aggregated probabilities upward and 2) real and substantial concern from sharers about this scenario. Two of the strongest concerns/reservations where sharers and non-sharers diverge are associated with the scenario itself (having to deviate from the evacuation route and adding extra time to the evacuation). We note that these concerns/reservations may not be enough to convince someone not to share, but they indicate that these concerns will need to be addressed, if employing sharing economy resources in a disaster/recovery effort. Between the wildfires, Carr Wildfire non-sharers for both scenarios had less reservations than the Southern California non-sharers. This indicates that addressing these transportation reservations would likely yield a less meaningful behavioral change for the geography impacted by the Carr Wildfire.

TABLE 7. Weighted Concerns/Reservations for 2017 Southern California Wildfires

	S1-Shelter-Cost		**S2-Shelter-Free**	
Concerns/Reservations About Sheltering an Evacuee (Full Sample)	Sharers	Non-Sharers	Sharers	Non-Sharers
Not having enough water and/or food	9%	33%	16%	38%

Uncertainty about one's own safety or security	17%	82%	27%	76%
Having to interact with a stranger	11%	55%	19%	54%
Feeling responsible for the additional house guest(s)	15%	71%	26%	69%
Having to drive the individuals around	2%	16%	8%	19%
Disruption of everyday tasks	11%	66%	23%	57%
General dislike of hosting	4%	30%	10%	28%
Not having enough space for the additional guest(s)' belongings	5%	35%	12%	39%
No government oversight	2%	10%	3%	7%

	S3-Transport-Before		**S4-Transport-During**	
Concerns/Reservations About Transporting an Evacuee (Evacuees Only)	Sharers	Non-Sharers	Sharers	Non-Sharers
Having to deviate from an evacuation route	26%	50%	43%	36%
Adding extra time to the evacuation	41%	69%	66%	48%
Not having enough fuel	15%	21%	22%	14%
Not having enough water and/or food	5%	9%	9%	8%
Uncertainty about one's own safety or security	33%	54%	51%	40%
Having to interact with a stranger	16%	31%	26%	28%
Feeling responsible for the additional passenger(s)	34%	55%	50%	39%
Having to drive the individuals for a long period of time	15%	29%	24%	21%
Not having enough space for the additional passenger'(s) belongings	41%	66%	60%	49%
No government oversight	4%	7%	6%	7%

TABLE 8. Weighted Reservations for the 2018 Carr Wildfire

	S1-Shelter-Cost		**S2-Shelter-Free**	
Concerns/Reservations About Sheltering an Evacuee (Full Sample)	Sharers	Non-Sharers	Sharers	Non-Sharers
Not having enough water and/or food	12%	40%	16%	32%
Uncertainty about one's own safety or security	14%	73%	31%	74%
Having to interact with a stranger	8%	42%	21%	47%
Feeling responsible for the additional house guest(s)	12%	63%	23%	56%
Having to drive the individuals around	5%	19%	9%	20%
Disruption of everyday tasks	9%	49%	21%	49%
General dislike of hosting	3%	23%	11%	27%
Not having enough space for the additional guest(s)' belongings	11%	51%	17%	38%
No government oversight	1%	6%	3%	5%

Concerns/Reservations About Transporting an Evacuee (Evacuees Only)	S3-Transport-Before		S4-Transport-During	
	Sharers	Non-Sharers	Sharers	Non-Sharers
Having to deviate from evacuation route	27%	36%	45%	22%
Adding extra time to the evacuation	40%	51%	66%	31%
Not having enough fuel	16%	16%	21%	8%
Not having enough water and/or food	7%	6%	7%	3%
Uncertainty about one's own safety or security	45%	51%	66%	37%
Having to interact with a stranger	14%	19%	25%	15%
Feeling responsible for the additional passenger(s)	22%	28%	38%	20%
Having to drive the individuals for a long period of time	10%	15%	18%	10%
Not having enough space for the additional passenger'(s) belongings	35%	50%	61%	33%
No government oversight	1%	1%	2%	1%

5. RECOMMENDATIONS

From the wildfire logistic results, we developed several evacuation recommendations for local agencies (see Table 9 below). We also provide specific recommendations derived from the modeling results to help build a strategy for private resource sharing in evacuations.

TABLE 9. Local Agency Recommendations

Recommendations from Wildfire Logistic Results		
SoCal = 2017 December Southern California Wildfires		*Carr = 2018 Carr Wildfire*
Recommendation	**Evidence**	**Discussion**
Improve evacuation order communication to reduce shadow evacuations by ensuring messages are sent to the appropriate geography with enough lead time	62.5% (SoCal) and 75.0% (Carr) of those who did not receive a mandatory evacuation order, still decided to evacuate (i.e., shadow evacuation)	Some shadow evacuees may not have received orders but perceived a high fire risk and evacuated. More clear communication of the fire risks and evacuation orders can help reduce the shadow evacuation rate and improve situational awareness.
Implement transportation strategies and traffic control in highly localized areas near evacuation zones	66.3% (SoCal) and 66.1% (Carr) of evacuees remained within their county.	Households for wildfire evacuations often remain close to the hazard and do not travel far distances to evacuate. Consequently, the highest traffic congestion will occur on local streets, not major highways. Traffic control should focus on high-risk neighborhoods in the evacuation zone and

	Most evacuations took under 2 hours (61.7% for SoCal and 52.3% for Carr).	neighborhoods with a high household-to-exit ratio (where bottlenecks are most likely to occur).
Plan for highly localized transportation and sheltering needs to support the local population		Beyond traffic control and shelter management, local agencies should also plan other strategies including providing accessible vehicles and shelters for functional and access needs population, long-term shelters for evacuees in the local community, and transportation for evacuees collecting supplies or reentering.
Assume and plan for high levels of multiple-vehicle evacuations, particularly for low-density geographies	94.3% (SoCal) and 95.7% (Carr) of evacuees used at least one personnel vehicle to evacuate. 49.2% (SoCal) and 61.8% (Carr) of evacuees took two or more personnel vehicles.	Most evacuees used personnel vehicles to evacuate and a significant proportion took additional vehicles. Traffic control plans and measures must recognize multiple-vehicle households, which increase evacuation clearance times. Longer evacuation clearance times will require larger lead times for issuing evacuation orders. Traffic control strategies, such as shoulder use and contraflow, may be necessary to handle demand.
Ensure enough public shelter capacity for at least 5% of the population	3.4% (SoCal) and 2.4% (Carr) of evacuees stayed at public shelters.	While other types of shelter were more popular than public shelters, local agencies should still be prepared for a high influx of evacuees, especially for larger wildfires. Since our data under sampled carless and low-income households, the actual public shelter usage rate was likely higher. Agencies should also avoid overcrowding, as these situations reduce quality of life.

Recommendations from Descriptive Statistics and Modeling Results		
Recommendation	**Evidence**	**Discussion**
Increase community trust and compassion as part of disaster preparedness to increase willingness to share resources	Trust, especially trust of neighbors and strangers, significantly increased willingness to share for most sharing scenarios. Compassion, especially non-selfish compassion and tender compassion, significantly increased willingness to share for most sharing scenarios Between 20.1% (Carr) 23.9% (SoCal) stated that trust in others substantially increased.	Trust and compassion were important factors in willingness to share, but it is not guaranteed that communities have adequate trust or compassion levels. Multiple approaches may be necessary to increase trust and compassion prior to the disaster. Strategies might include building community cohesion through civic pride (e.g., identity, slogans, flags, campaigns), easy-to-replicate neighborhood networks (e.g., phone trees, neighborhood associations), social neighborhood events (e.g., block parties), preparedness events (e.g., community meetings, training), and disaster-specific neighborhood groups (e.g., Community Emergency Response Teams (CERT)). Some trust/compassion building strategies, such as developing community carpools, could function under both normal conditions and disaster conditions. Support for these

		strategies could come from monetary grants or local fire marshals, chiefs, and boards with knowledge expertise. Developing preparedness guidebooks and brochures would help increase both preparedness and willingness to share, especially if the materials include information on how to share. Agencies should also consider training leaders within neighborhoods on how to connect sharing providers and users. Trustworthy and compassionate leaders and providers are likely rooted in the community and/or have strong social connections.
Ensure that community members, including evacuees, can easily volunteer	Past volunteers in disasters were moderately more likely to share for several sharing scenarios. Volunteerism was high for the wildfires as 44.2% (SoCal) and 46.8% (Carr) volunteered. Volunteerism for the wildfires increased by 7.5% (SoCal) and 13.3% (Carr) compared to past volunteerism. Members of a local community organization or group were typically more likely to share for several sharing scenarios.	A significant number of respondents were active volunteers in the wildfires. Given that many individuals also evacuated, agencies should make volunteering easy (e.g., developing volunteering groups, fast signup), which will help to increase the amount of resources available for response, recovery, and future disasters.
Maintain volunteer networks to keep volunteerism high for the next disaster		Past volunteers were more likely to share under certain circumstances, indicating that volunteer networks should be part of a sharing strategy. Network maintenance may require local agencies to reward assistance through volunteer recognition, communicate with volunteers on a regular basis, and host social gatherings for volunteers.
Develop closer partnerships with CBO volunteer networks, which can be called upon in a disaster for transportation and sheltering		Some community organizations are well-positioned in the local area to provide rapid response in disasters, due to their volunteer and supply networks. Members of community organizations can provide needed transportation and sheltering resources through a more trusted organization (instead of through private citizens). Some networks already exist and should be expanded (e.g., American Red Cross, churches), but more local organizations may be more flexible in meeting community needs.
Link local CBOs and volunteer networks with known centers, neighborhoods, and communities with a high proportion of access and functional needs populations	13.0% (SoCal) and 3.2% (Carr) of respondents received a mandatory evacuation order but did not evacuate Members of a local community organization or group were typically more likely to share for several sharing scenarios.	Some individuals continue to remain at home even though they received a mandatory evacuation order. While some individuals may defend their home, others are unable to leave due to lack of resources and/or low mobility. Local CBOs could provide resources, especially since organization members are more willing to share resources. Agencies may need to first compile a list of areas with functional and access needs populations. Public assets may be

	Past volunteers in disasters were moderately more likely to share for several sharing scenarios.	able to meet these needs, but CBOs may be well-equipped to aid when necessary.
Increase public resources (e.g., public transit) and/or NGO and CBO resources (e.g., carpools) for areas that previously evacuated from wildfires	Previous evacuees were less likely to share for several sharing scenarios.	Past evacuation experience decreased willingness to share, perhaps due to poor experiences with heavy congestion. Local public transit and emergency management agencies should deploy resources to areas that they previously evacuated, as private citizens in these areas would also be less likely to spontaneously share. Additional resources may also increase compliance with mandatory evacuation orders. Agencies will need to maintain continuity of knowledge to ensure that previously evacuated areas and fire perimeters are identified and mapped.
Minimize safety concerns by matching providers and evacuees through established CBOs	Safety and security concerns were expressed by a significant number of respondents for both transportation and sheltering. Non-sharers were especially concerned. Members of a local community organization or group were moderately more likely to share for several sharing scenarios. Respondents were not concerned about the lack of governmental oversight for a shared resource strategy.	With safety as a primary concern, both providers and users of shared resources may be more comfortable with sharing through established CBOs and volunteer networks. CBO credibility may also increase trust of neighbors and strangers. While local agencies could also match providers and users, CBOs are well-positioned to encourage members and other volunteers to share resources. Private sharing companies often partner with CBOs to provide rides and shelter.
Leverage police and fire personnel to communicate the need to share and check on neighbors	High police presence on the route increased willingness to share transportation while evacuating for both SoCal and Carr. High pressure from officials to leave somewhat increased willingness to share transportation before evacuation for SoCal. Mean trust of police was higher than trust of neighbors.	Public officials, particularly police and fire personnel, assist in distributing evacuation orders within neighborhoods. Authority figures with subject matter expertise (e.g., fire marshals and firefighters for wildfires) may be highly trusted in disasters, especially if they provide accurate and useful public information. This trust level may allow experts to communicate additional information on how to share transportation and sheltering and check on neighbors during the disaster. Moreover, since police and fire are assisting within neighborhoods, they can communicate directly with sharing providers and users. Other public officials and local politicians can also play a role in communicating sharing needs to the community.

Reduce liability concerns by reiterating "Good Samaritan" laws, which protect compassionate behavior	Concerns over feeling responsible for the passenger(s) or guest(s) was a major concern for respondents for both transportation and sheltering and especially for non-sharers.	Liability remains a key limitation that could be addressed through organized networks (e.g., through CBOs) or through local laws (e.g., Good Samaritan laws). These laws protect citizens who assist, particularly emergency care, from civil damages. Sharing behavior, which could also be protected by an extension of these laws, may increase willingness to sharing transportation and sheltering. Local agencies should also research other laws and protections for providers and users.
Set pickup points for shared transportation along major arterial roadways	Respondents stated that two of their primary reservations of sharing were the possibility of a longer evacuation and having to deviate from the evacuation route. Both sharers and non-sharers were highly concerned.	With such limited time to evacuate and travel to a destination, evacuees exhibited strong risk aversion to increasing the travel time of their evacuation or deviating from their route. A future shared resource strategy should consider pickup points along major arterial roadways to reduce the need to deviate. These pickup points could also be integrated into a public transit-based response. Not all individuals will be able to travel to these pickup points so some vehicles will have to provide point-to-point service to ensure safe and equitable outcomes.
Increase community trust and compassion during and after the disaster to increase willingness to share resources	Trust, especially trust of neighbors and strangers, significantly increased willingness to share for most sharing scenarios. Compassion, especially non-selfish compassion and tender compassion, significantly increased willingness to share for most sharing scenarios Between 20.1% (Carr) 23.9% (SoCal) stated that trust in others substantially increased. Several urgency variables (e.g., high visual fire level, high smoke level, high traffic levels and low visibility) increased willingness to share transportation, indicating that sharing can be triggered by the disaster.	While a significant amount of trust/compassion building can occur prior to the disaster, some strategies could be used during or after the disaster. Based on the significance of urgency variables, disasters may help to trigger sharing behavior. Local agencies can encourage this behavior by using community-building language (e.g., positive and encouraging press releases focused on community strength and resilience), communicating directly with local neighborhood associations, leaders, or CERT teams, and encouraging sharing response – especially transportation pickups – in high urgency neighborhoods with proximity to the fire. Agencies can also offer continuing information on community needs throughout the wildfires and recovery, including how residents can supply long-term sheltering or transportation for evacuees to gather basic necessities or access health care.

6. CONCLUSIONS

In this paper, we explored wildfire logistics and the feasibility of the sharing economy for wildfire evacuations using survey data from the 2017 December Southern California Wildfires and the 2018 Carr Wildfire. For wildfire logistics, we found low non-compliance rates, a significant number of multi-vehicle evacuations, and high usage of family and friends for sheltering. Public shelter use and peer-to-peer services were low for both wildfires, and most evacuations were within county. We also found evidence of spare capacity across evacuating vehicles for both wildfires.

Using four sharing scenarios, survey respondents were somewhat likely to share shelter at cost, moderately likely to share shelter for free and transportation before an evacuation, and very likely to share transportation while evacuating. A significant number of wildfire respondents recently volunteered and perceived trust increases in their community following the wildfires. Through eight binary logit models, we found a nuanced story regarding willingness to share that was highly dependent by scenario and wildfire. We found a strong presence of trust and compassion in increasing willingness (confirming our original hypothesis), moderate impact of evacuation urgency, and weaker impact of evacuation circumstances and demographics. Moreover, we found that non-sharers had considerably more concerns/reservations about sharing than sharers, with the exception of transportation during the evacuation, which suggests that concerns will need to be addressed to retain a higher likelihood of sharing.

We conclude that a sharing economy strategy is feasible for wildfire evacuations, albeit with some important limitations including sharing reservations and sometimes low willingness depending on the scenario. We recommend that future sharing economy strategies should build trust and compassion prior to disasters within neighborhoods, CBOs, and volunteer networks, but they should also leverage communication mechanisms to trigger trusting and compassion responses during an evacuation. We recommend that future work, such as Sadri et al. (2018), continue to assess social capital and social networks in evacuations. Future work should also continue on the demand side of the sharing economy, such as the work conducted by Borowski and Stathopoulos (2020), especially by asking evacuees about their mode choice in previous events. We hypothesize that sharing can be developed pre-disaster, but it can also be activated, guided, and promoted by agencies during a disaster. While the sharing economy may remain an evacuation tool for only a small fraction of the community, an increase in resources would help more citizens access transportation and sheltering. Future work should continue to build upon this research through the exploration and development of a practice-ready framework for building trust in the community as part of disaster preparedness, which addresses barriers to resource sharing.

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8. CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design: S. Wong and S. Shaheen with input from J. Walker; data collection: S. Wong; analysis and interpretation of results: S. Wong and S. Shaheen; draft manuscript preparation: all authors. All authors reviewed the results and approved the final version of the manuscript.

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